BREAKING THE ICE IN ARCTIC NAVIGATIONAL RESEARCH

Navigation of the ice-covered waters of the Canadian Arctic has been going on since the mid-1500s, when former pirate Martin Frobisher set sail for a Northwest Passage sought even then for its promise of the fastest possible route between Europe and the Orient. Frobisher's frail wooden ship made it as far as the Bay that he named after himself, but by the 1900s, the barriers to commercially viable Arctic navigation appeared insurmountable, and quests for the Passage were virtually abandoned. Within the past decade, however, navigating the oceans of the midnight sun has again become a major commercial priority, spurred this time not so much by the need for a short northern sea lane as by the intense interest in developing Northern hydrocarbon and mineral resources.

These discoveries have led to the remarkably rapid development of large ice-breaking oil and gas carriers mammoth in both proportion (150,000 tonnes) and cost (approximately $350 million each). Since the design of these vessels is regulated under the Arctic Shipping Pollution Prevention Regulations of the federal Arctic Waters Pollution Prevention Act, the stepped-up pace at which such ships are being proposed has required that the Canadian government move quickly to update the Regulations: human and ecological safety considerations, as well as an efficient Northern shipping system, must be ensured.

Consequently, Transport Canada has since the early 1970s been spearheading research projects aimed at discovering how ice and ships in Canadian Arctic waters affect each other. Precedents for this type of research have been established in both the Russian Arctic, where the development of massive nuclear ice-breakers, in particular, has been going on since World War II, and in Finland, an acknowledged leader in research on ice navigation. However, since the Canadian Arctic presents challenges more awesome than those found in either the Baltic Sea of the Finns or the Arctic waters of the Russians, Canada has been forced, over the past decade, to pursue her own answers. In the process, she is herself rapidly becoming a leader in the area of ice navigation.

To date, much of the work commissioned by Transport Canada has focussed on the impact of ice on a vessel's hull. As an important element of Transport Canada's R & D effort, the department's Transport Development Centre (TDC) has developed programs on hull research that encompass analytical studies, laboratory work and field tests. Analytical studies based on computer modelling explore such aspects as the nature of ice failure (that is, the way it breaks) and dynamic loading (the impact of ice on the ship's hull as the ship encounters it while moving through the water). The resulting predictions about the basic physics involved are then subjected to confirmation by laboratory studies using actual models. Finally, full-scale tests of vessels specially instrumented to measure the effects of ice loading is the surest, if most expensive, way to confirm a practical level of knowledge.

Using the expertise of several Canadian firms, Transport Canada has over the past four years conducted field tests aboard the Canadian Coast Guard vessels Pierre Radisson (1978), and Louis St. Laurent (1977 and 1980), as well as on the Motor Vessel "Arctic" (1979-82). The M.V. Arctic investigations, to be completed this summer, followed up needs uncovered by the earlier studies, which clearly indicated that the response of the entire ship structure would require more research attention.

The M.V. Arctic is a commercial vessel shared by the Canadian government, which owns 51 per cent of the operating company, Canarctic Shipping Limited, and Northwater Navigation Limited, owner of the other 49 per cent. An ice-strengthening Class II cargo ship, the "Arctic" carries lead and zinc out of Nanisivik to European ports, usually in five round-trip voyages during the Arctic season that begins at the end of June and ends in mid-November.

To the federal government, the M.V. Arctic has from the time of its 1978 launching represented more than just an opportunity to assist a segment of the Arctic shipping industry to become commercially viable; the ship has served concurrently as a tool for scientific research.

Instrumentation centre aboard M.V. Arctic.
(Photo courtesy of Transport Development Centre, Montreal)

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The first research contracts placed by TDC were awarded in 1979, TDC's long-term aim being to thoroughly investigate the ice-breaking capability of ships like the Arctic.

Recent projects awarded by the Science Centre include:

— A contract awarded to Arctic Canada for testing and evaluation of an air cushion ice breaking bow — data collection and analysis

— Participation in the 1981 scientific testing program using the ice breaker Canmar Kigoriak.

— An unsolicited proposal awarded to study the magnitude and characteristics of the loads imposed on steering systems due to ship/ interactions.

— A Calgary firm has been awarded a number of contracts for stress analysis on the M.V. Arctic. The most current contract is featured page 28 of this bulletin for measurement, recording and analysis of deck and bottom stresses on M.V. Arctic during a trans Atlant crossing.

Instrumentation developed by German and Milne Incorporated of Montreal was installed in the ship and consisted of 165 strain gaug in the bow structural region and about 80 sensors attached to machinery components monitoring the ship's speed, engine power, RPM thrust, propeller pitch and shaft torque, all of which enabled data to be gathered during the vessel's commercial voyages. In the three years since, supplementary information has been obtained during four voyages exclusively dedicated to scientific research. Among th companies participating in the data gathering have been German and Milne, Fenco Consultants Limited, Arctec Canada Limited, and Melville Shipping Limited.

NRC researchers on Lake Melville measure the strength of ice by cutting ice tongues that are then subjected to increasing pressure.

(Photo courtesy of the Arctic Vessel and Marine Research Institute, NRC).

The data collected so far has yielded a wealth of information pertinent to the design of ice-transitting ships still on the drawing boar

- It has now been established that ships built like the M.V. Arctic can, under certain conditions, handle more than the two feet of ice previously associated with a Class II ship. The Arctic can progress continuously through up to three feet of first-year ice.
- The M.V. Arctic's propeller is fitted with a nozzle or duct that has proven very beneficial for ice-breaking ships. Clearly invulnerable ice-induced damage, the nozzle improves the efficiency of the propeller by enabling it to give higher thrust at low speeds.
- The M.V. Arctic is also equipped with an aerator system that ejects air bubbles along the bottom and sides of the ship. These act a lubricant that has proven highly efficient in reducing ice friction at low speeds.
- A solvent-free epoxy coating of paint has been found virtually impervious to the ravages of ice, and therefore offers the ship's hull efficie protection from corrosion while also reducing friction.

During the current season the M.V. Arctic is testing a new navigation aid warning system (NAWS) that will tell the ship's navigator when the ship is undergoing dangerous levels of strain. Without such a system a ship could encounter major structural damage, such a perforation of its hull, long before the navigator or crew can distinguish the ship's immediate physical response from the normal shocks that frequently occur. The NAWS system maintains a green light during safe levels of strain, an orange light when specific lo levels are encountered, and a red light when strain is potentially dangerous. In addition, the mimic-display is designed to indicate the location of the ice impact on the hull.

The NAWS experiments are the last of the current series of on-ship research projects undertaken by TDC, which has now begun the first phase of an intensive analysis of the data assembled so far. Preliminary contracts have already been awarded to German and Milne for assembly of a data package, and to Fenco for devising a programming technique for converting the strain gauge reading of hull-ice impact into ice loads. Projected to take 18 months, the work will be contracted under such areas of interest as ship manoeuvering in ice, vibrational characteristics and motions, ice impact, and evaluation of the instrumentation system itself.

t even before the in-depth analysis is completed, certain general trends in the future design of ice-going ships can be predicted. cording to Ian Glenn, Senior Vice President of Arctec Canada Limited, it is becoming evident in the industry that the design of ships gotiating heavy ice will be significantly influenced by the magnitude and nature of loads imposed on them by the heavy ice they ıst negotiate. Bow geometry, for example, will probably be chosen for its ability to minimize impact forces. The way in which hulls stiffened will undoubtedly undergo radical changes; already, Humble Oil's ice-breaking tanker SS Manhattan, — the first mmercial tanker to transport oil through the Northwest Passage — features a double hull that protects the environment from a lluting spill in the event of ice penetration. Increased overall strength amidships, buoyancy restoration devices, and greater odivision of the hull, which would enable containment of flood waters in one compartment while protecting the remaining mpartments, are all possible components of the ice-breaking cargo ships of the near future. Many people in the industry are edicting that, if the goals of the Arctic Pilot Project are to be met, several of these techniques could be standard within the next two ırs.

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Forthcoming requests for proposals

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ASSESSMENT OF THE PHYSIOLOGICAL COST OF PHYSICAL WORK IN SUSTAINED OPERATIONS

The Department of National Defence has considerable interest in research to improve the performance of soldiers during sustained operations. A significant effort at the Defence and Civil Institute of Environmental Medicine (D.C.I.E.M.) is presently being devoted to the effects of sleep deprivation on command and control functions. Future research will also address the problems of sustained physical work and the limitations imposed by battlefield conditions.

The tasks performed by troops in battle, forced marches, infantry assault, digging-in or loading ammunition and fuel are a confusing mixture of aerobic and anaerobic, isometric and dynamic work. Existings methods, such as the measurement of oxygen consumption or the rating of perceived exertion, are most often applied in laboratory situations where the exercise is well-controlled and clearly defined. Although such methods can be used and will provide useful information, there is a requirement to identify methods which are more appropriate for use in experiments conducted under simulated battlefield conditions.

Requests for Proposal (RFP) may be invited to determine methods of measuring or assessing the physiological cost of physical work performed during a military exercise which simulates aspects of the battlefield. Of particular interest is work with a significant isometric component such as digging and lifting. The term physiological cost is used to indicate an interest in other aspects besides energy expenditure. The RFP may involve modification of existing methods, novel approaches or new technology.

Interested organizations are requested to submit a concise statement of no more than three (3) pages by 30 June 1982 detailing qualifications, capabilities and relevant experience.

A Request for Proposal may be issued to all organizations responding to this announcement and to any other qualified organizations identified through the DSS Science Procurement Information Network.

Statements should be submitted to:

Mr. F.S. Thomas
Regional Science Procurement Manager
Ontario Region Supply Centre
295 The West Mall, Suite 200
Etobicoke, Ontario
M9C 5A4

Telephone: (416) 622-8111 Ext.213

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PRELIMINARY ANNOUNCEMENT: SUPER WINDOW TECHNOLOGY AND PRODUCT DEVELOPMENT

The Solar Energy Program, National Research Council, is planning a major multi-year initiative on developing "super windows". A Request for Proposals (RFP) will be issued towards the end of May. The window is seen as the weak link of a low-energy passive solar building. With present designs of windows, there are problems with glazing heat loss, air leakage and thermal bridging. Moveable insulation systems are proving to be expensive and relatively ineffective.

The purpose of this new initiative is to develop new cost effective window designs which combine good thermal and optical performance. The new products must represent a substantial improvement in thermal impedance compared to conventional double glazed windows. The scope of work proposed can include the development of new glazing materials or coatings the design of innovative window units which incorporate available glazing materials and hardware products, or any other innovative approach to the problem of window design. Multi-phased proposals will be accepted for review and the scope of work to be included in first phase should be directed towards solving key technical problems. The proposals should contain estimates of further funds, if required, to fully develop and test prototype and production models.

It is planned that $250,000 will be available in this financial year which ends on March 31st, 1983 with increased funding in the following years. Over a three-year period, it is expected that funds in excess of $2 million will be made available for product development of super windows. The future allocation of these funds is conditional on receivin proposals of sufficient technical merit. To allow research teams a further opportunity to participate in this initiative, it is planned that a second RFP will be issued within a year. Research teams are encouraged to take advantage of this long lead time to develop in-depth proposals.

Organizations interested in submitting proposals may obtain a copy of the RFP from:

Dr. N.M. Ahmed
Science Procurement Manager
Science Procurement Branch
Science Centre
Supply and Services Canada
10C1, Phase III
11 Laurier Street
Hull, Qubec
K1A 0S5

Telephone: (819/613) 997-6027

The deadline for receipt of proposals will be specified in the RFP.

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